Air Force Center for Engineering and the Environment

Integrity - Service - Excellence

Building Sustainability into the Air Force Remediation Process

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Environment, Energy and Sustainability Symposium (E^2S^2)

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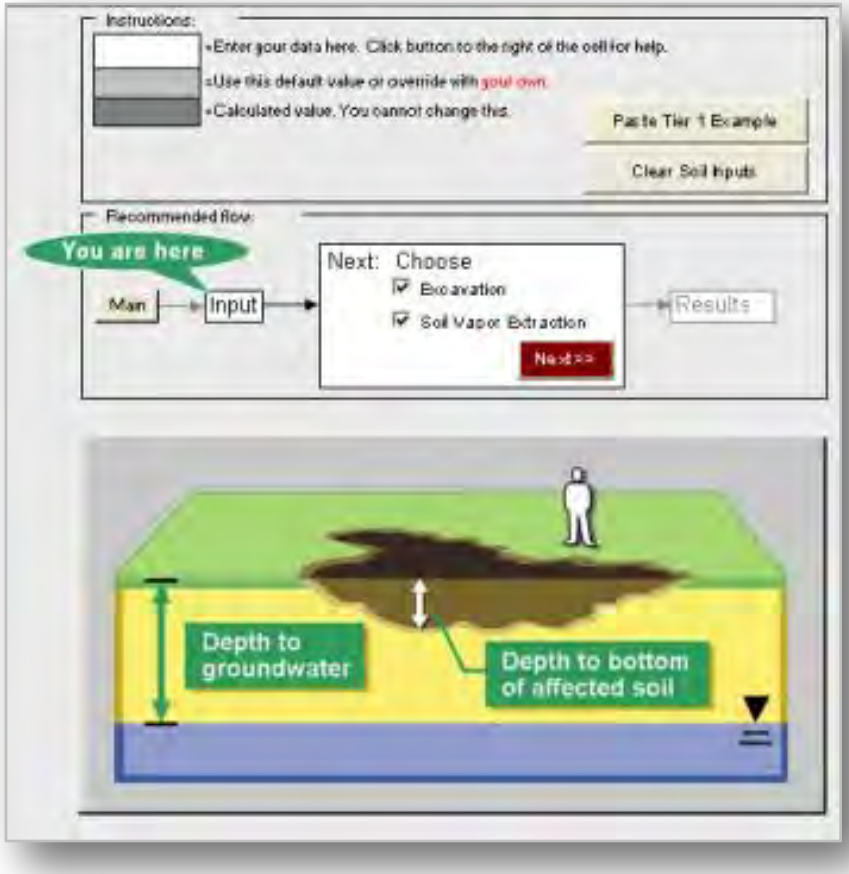
Sustainability in AF Remediation:

Presentation Overview

- "Green" remediation
  - Technologies
  - Approaches
- Challenge
- Solution
- Sustainable Remediation Tool (SRT) – How does it work?
- Status
- Resources



"Green" Remediation

- **Sustainability metrics not new endeavor**
- **ER programs focus on cost, risk reduction, compliance with existing laws, and other metrics**
- **Sustainable approaches investigated and promoted for years**
- **Some treatment technologies inherently sustainable and generally considered "green"**

EPA on green: Considers all environmental effects of remedy implementation; incorporates options to maximize net environmental benefit of cleanup actions

Phytoremediation, Travis AFB, CA

USAF "Green" Remediation

Goal has always been to reduce remediation system costs

Focus has been on working with and leveraging Mother Nature

50% of current AF systems considered "Green"

Sustainable remediation technology examples:

- **Phytoremediation – 5**
- **LNAPL recovery – 16**
- **Passive in situ treatment**
- **Wetlands**
- **Enh bio – 114**
- **MNA – 105**
- **Biowalls – 11**
- **Solar-powered systems – 7**
- **PBDS – 5 (ANG alone)**

Solar-powered in situ bioreactor, Altus AFB, OK

USAF "Green" Remediation

Beginning to purposefully analyze sustainability as part of selection criteria for new remediation systems as well as for optimization

- MMR, MA – Wind turbine to power groundwater cleanup
- Altus AFB, OK –
  - Solar-powered in situ bioreactor with pump
  - Biowall replaces pump-and-treat
- Travis AFB, CA – Solar-powered pumps for pump-and-treat system; in situ bioreactor
- Hickam AB, HI – Solar-powered in situ bioreactor
- Patrick AFB, FL – Solar-powered aerator
- Kennedy Space Center, FL – Solar-powered recirculation system
- Sustainable Remediation Tool


Wind turbine, MMR, MA


Solar-powered in situ bioreactor, Travis AFB, CA


Solar-powered pumps, Travis AFB, CA

USAF "Green" Remediation

In addition to some remediation technologies inherently sustainable, various approaches applied to restoration programs:

- **ERP-O (Environmental Restoration Program – Optimization)**
- **LTMO (Long-term monitoring optimization)**
- **Groundwater modeling**
- **PBM (Performance-based Management)**
- **Contract regionalization**

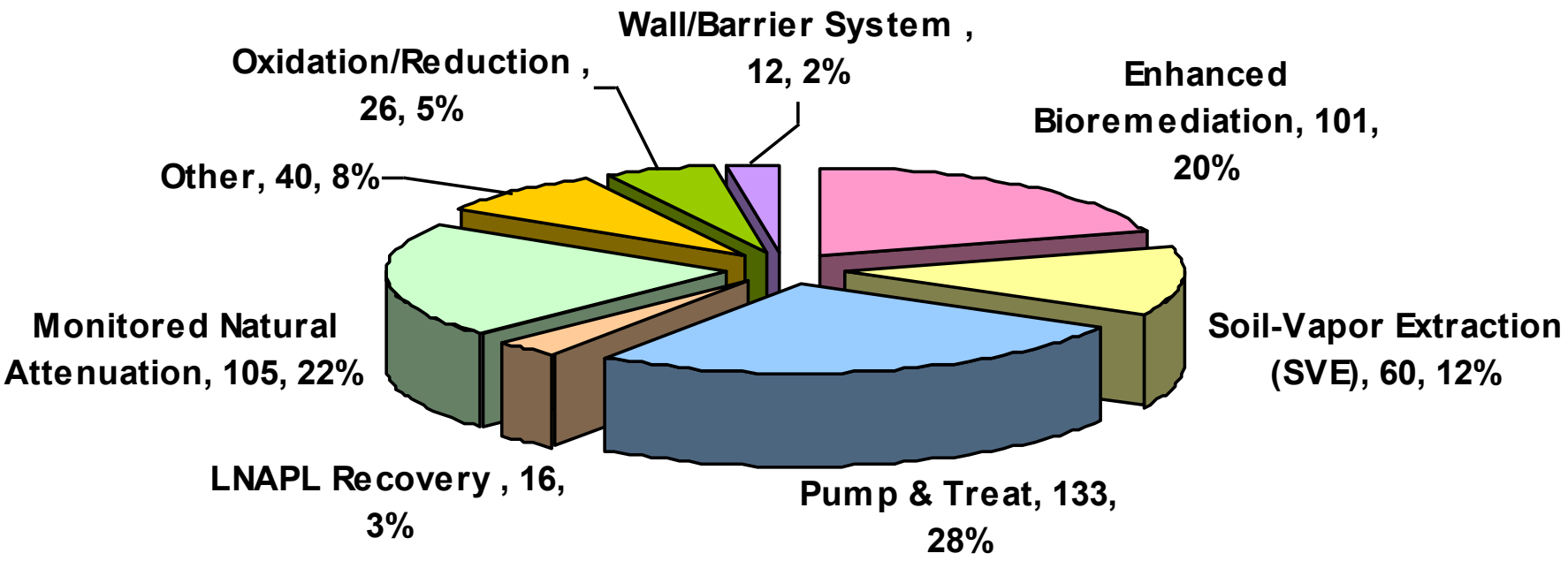
These optimize existing remediation and monitoring systems, and provide holistic and systematic results-based assessment of restoration programs to expedite site closure

Remedial Process Optimization (RPO)

- **Systematic approach for evaluating existing cleanup & monitoring systems with goal of improving effectiveness & reducing overall site cleanup costs without increasing risks**
- **All cleanup activities, both interim and final**
- **Mandated in Air Force RPO „04Policy**
- **Accelerate RC by achieving site cleanup levels more efficiently**
- **Optimize in-place cleanup systems and LTM to minimize O&M cost**
- **Move away from active/energy consumptive remediation systems**
- **Uses several tools, e.g., PTT, SRT**

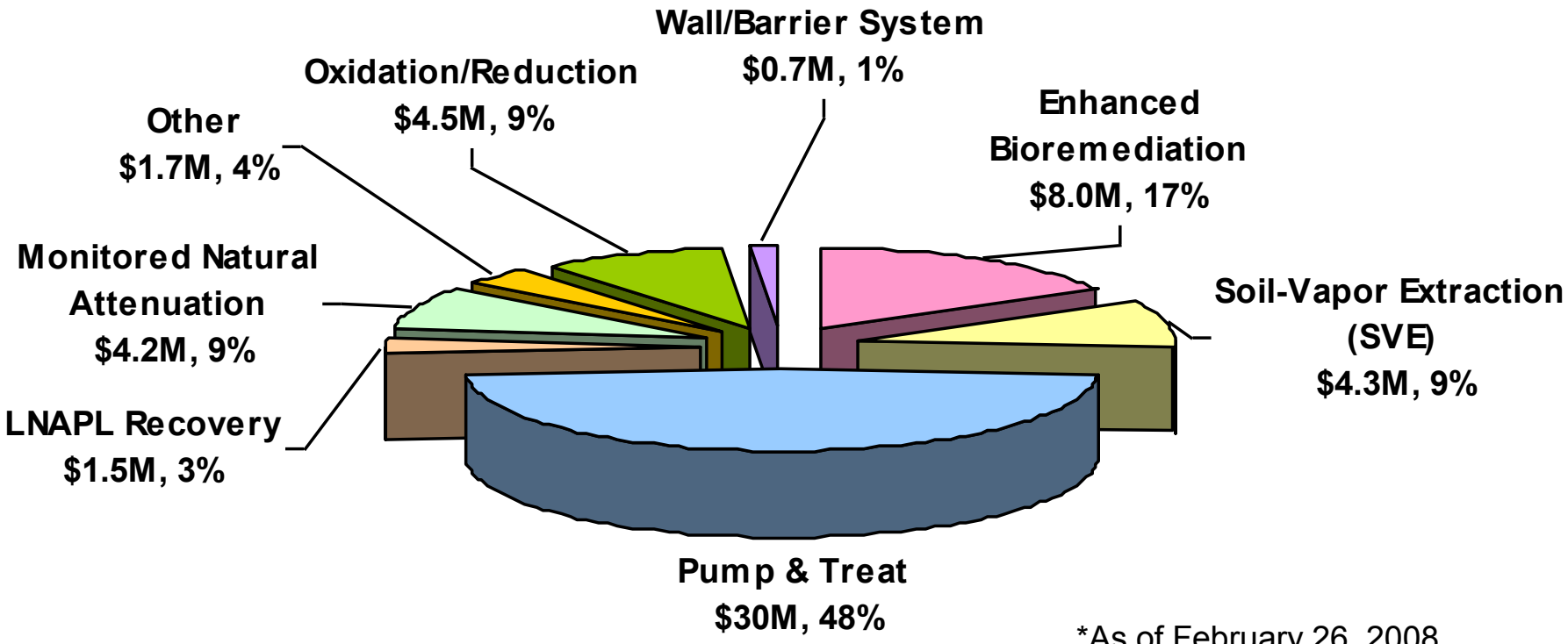
RPO Driver

FY07 Number of Systems by Technology



*As of February 26, 2008

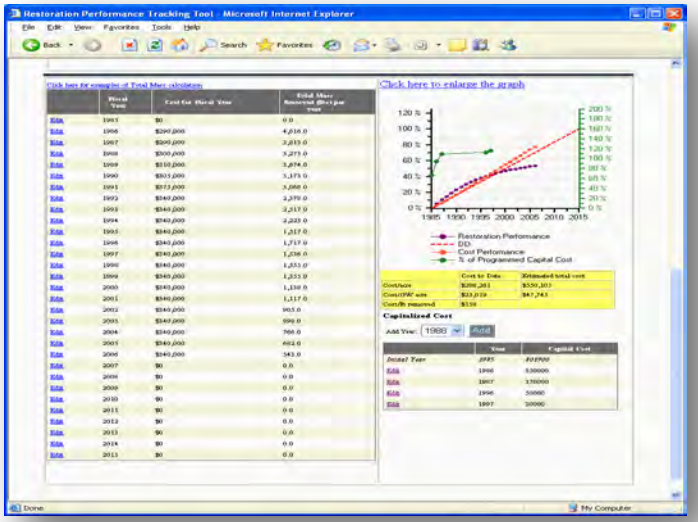
FY07 System Cost by Technology



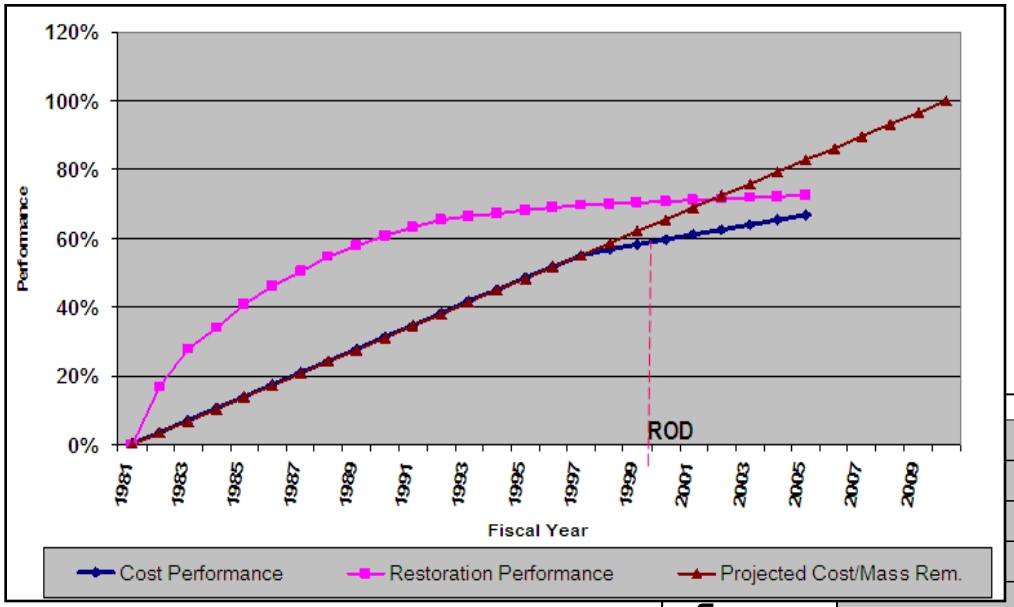
*As of February 26, 2008

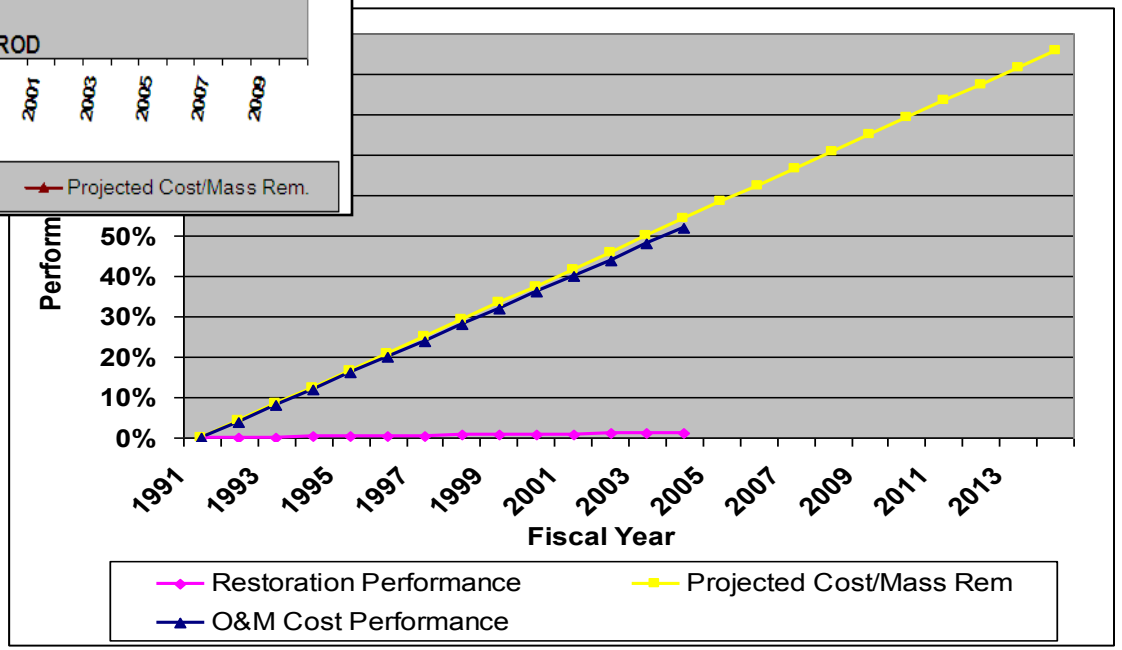
Performance Tracking Tool (PTT)

- **Remedial objectives evaluation tool as Excel™ spreadsheets**
- **Addresses two key questions:**
  1. **Is contaminant mass being reduced at anticipated rate?**
  2. **Is the O&M cost consistent with projections?**
- **Current technologies: P&T, SVE, bioslurping, MNA, dual-phase extraction, solvent extraction**
- **Calculates actual and compares to expected mass removal**
- **Promotes regular evaluation of remedial system performance**
- **Illustrated ineffectiveness of two P&T systems – resulted in system shutdown, cost savings > $2M/yr**



PTT Example Case Studies





The Challenge…

Historical approach to contaminated sites does not fully consider sustainability concepts.

New paradigm for remediation propelled by Executive Order (EO) 13423, January 2007.

Call to operate in "sustainable manner" leaves government environmental restoration professionals with need for tools to help develop sustainable remediation practices.

Sustainable: "to create and maintain conditions, under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic, and other requirements of present and future generations of Americans" (EO 13423, Bush 2007)

A Solution…

Develop Sustainable Remediation Tool (SRT) to help AFCEE environmental professionals incorporate sustainability concepts into their remediation decision making process (*e.g.*, PBEM, RRM, ERP-O) for:

i) Planning future remediation implementation

ii) Optimizing operating remediation sites

Tool will be available as freeware

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SRT

What the Tool Does

Estimates sustainability metrics for specific technologies:

1. **Excavation**
2. **Soil Vapor Extraction**
3. **Pump and Treat**
4. **Enhanced Bioremediation**

Next release will have additional technology modules

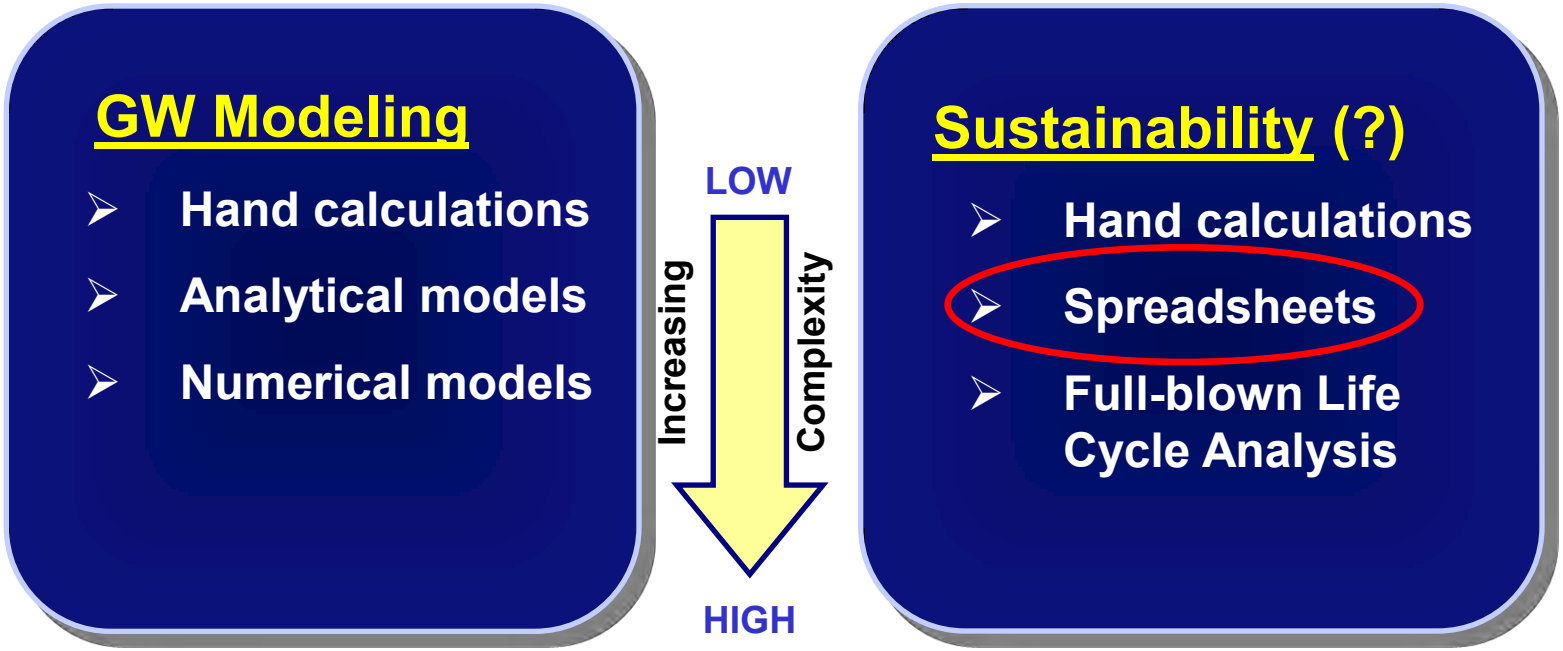
What the Tool Does

Sustainability metrics developed:

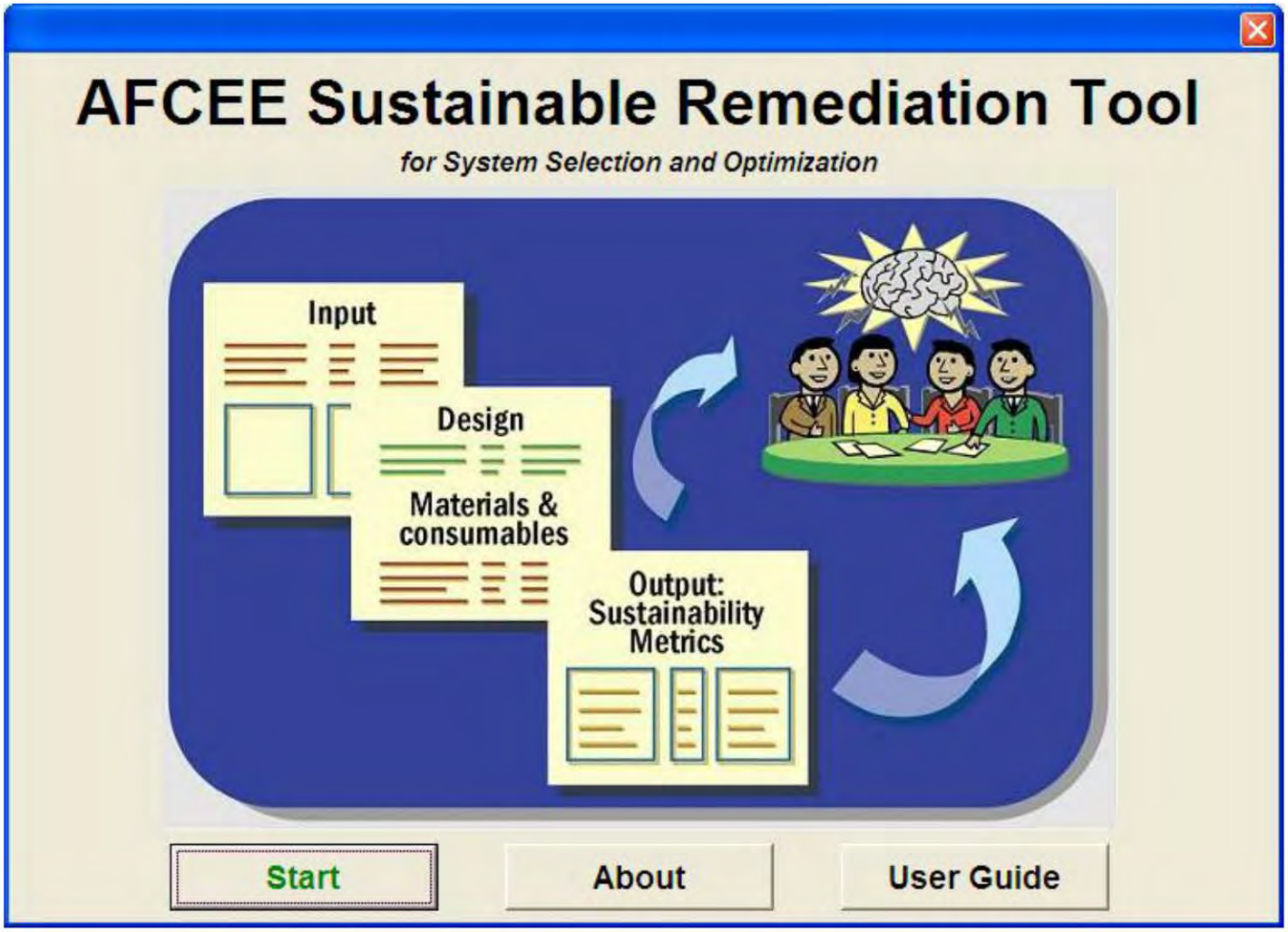
- **Carbon dioxide emissions to atmosphere**
- **Total energy consumed**
- **Change in resource service**
- **Technology cost**
- **Safety / Accident risk**

Next release will have add additional metrics

Levels of Complexity for Calculation Tools

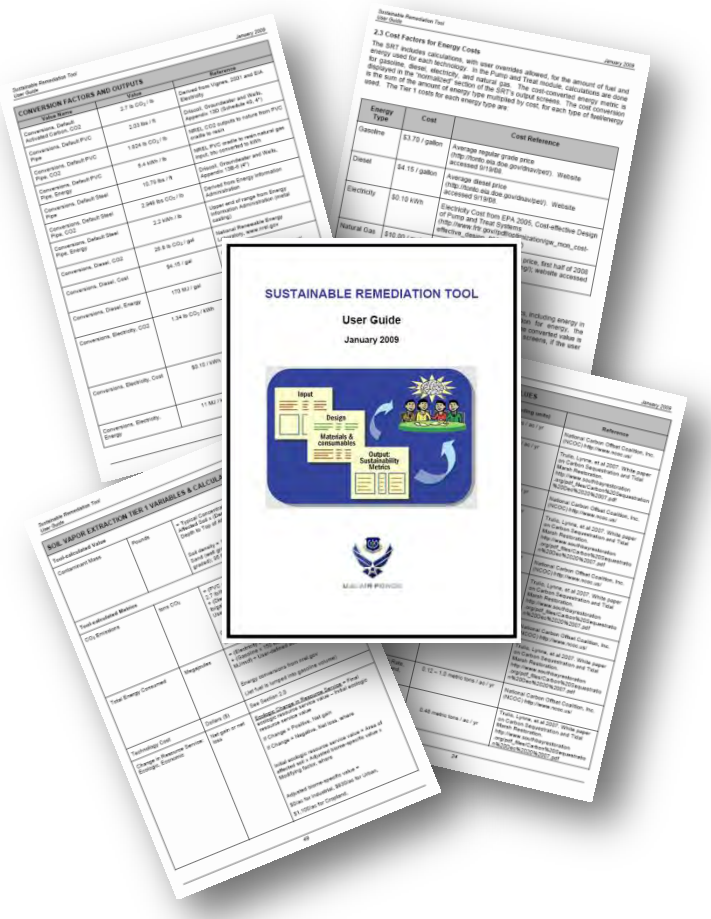


SRT – How Does it Work?



SRT – How Does it Work?

- User's Guide
  - Background
  - What the SRT does
  - Tier 2 System
  - FAQs
  - Referenced values
  - Acronyms and abbreviations
  - Technology costs and other detailed calculations
- SRT checklist
  - Soil input
  - Groundwater input
  - Technology input



SRT – How Does it Work?

Like RBCA Toolkit!

Tiers of Varying Detail

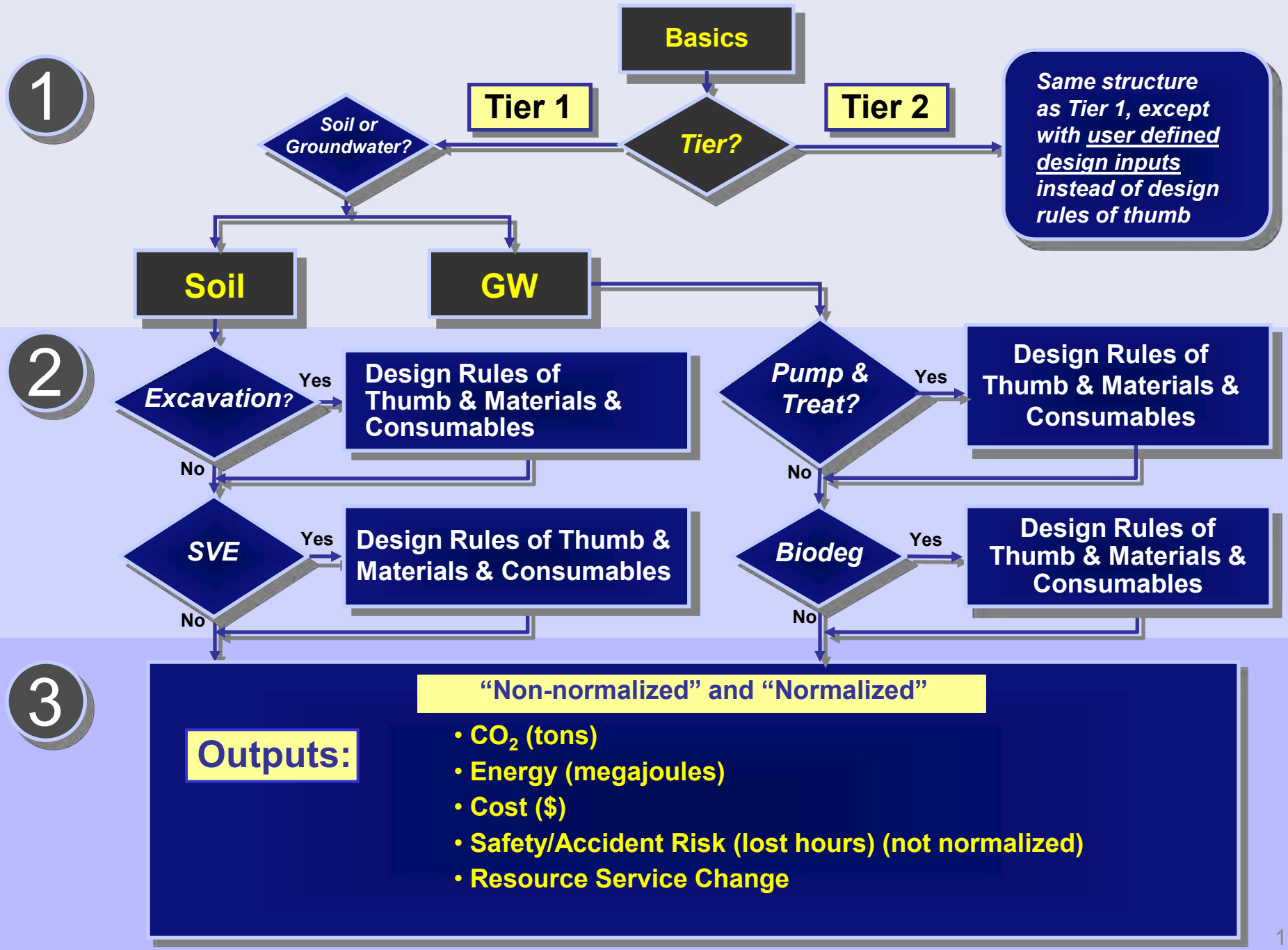
	Tier 1	Tier 2
Calculation Basis:	"Rules of Thumb"	User-entered detailed design
Time Required:	1 - 2 hrs	1 - 2 days

Tier 1 Advantages:

- ✓ Shorter execution than Tier 2
- ✓ Extensive built-in defaults
- ✓ Simpler user inputs
- ✓ Most appropriate before a Feasibility Study

Tier 2 Advantages:

- ✓ More site-specific results
- ✓ More default user-overrides
- ✓ Most appropriate after a Feasibility Study
- ✓ More appropriate for optimization of existing systems


1
Basics
Tier 1
Tier 2
Tier?
Soil or Groundwater?
Same structure as Tier 1, except with user defined design inputs instead of design rules of thumb
Soil
GW
2
Excavation?
Yes
Design Rules of Thumb & Materials & Consumables
No
Pump & Treat?
Yes
Design Rules of Thumb & Materials & Consumables
No
SVE
Yes
Design Rules of Thumb & Materials & Consumables
No
Biodeg
Yes
Design Rules of Thumb & Materials & Consumables
No
3
Outputs:
"Non-normalized" and "Normalized"
• CO_2 (tons)
• Energy (megajoules)
• Cost ($)
• Safety/Accident Risk (lost hours) (not normalized)
• Resource Service Change

SRT – How Does it Work?

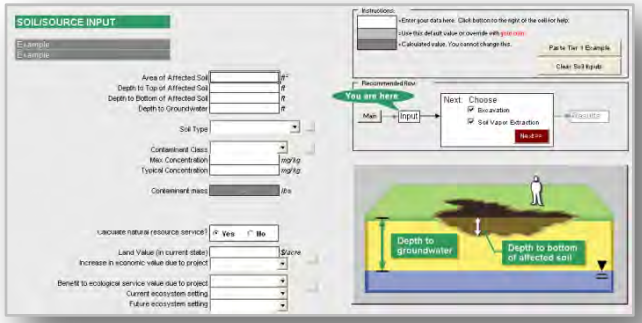
By project phase – Capital, O&M, or capital and O&M

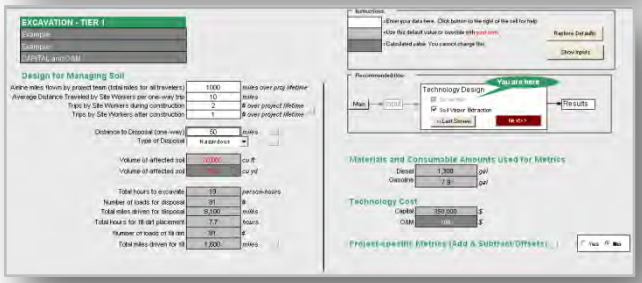
Add & subtract offsets – Technology cost; total energy consumed; CO_2 emissions; Safety/accident risk

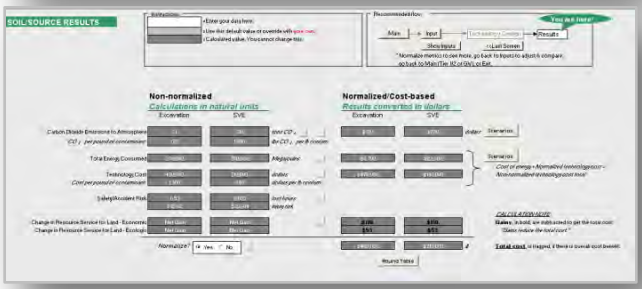
Current and future ecosystem setting – Industrial, urban, cropland, grassland, forest

Increase in economic value and benefit to ecological service

Springboard for features – CO_2 Scenarios; energy scenarios; Stakeholder Roundtable



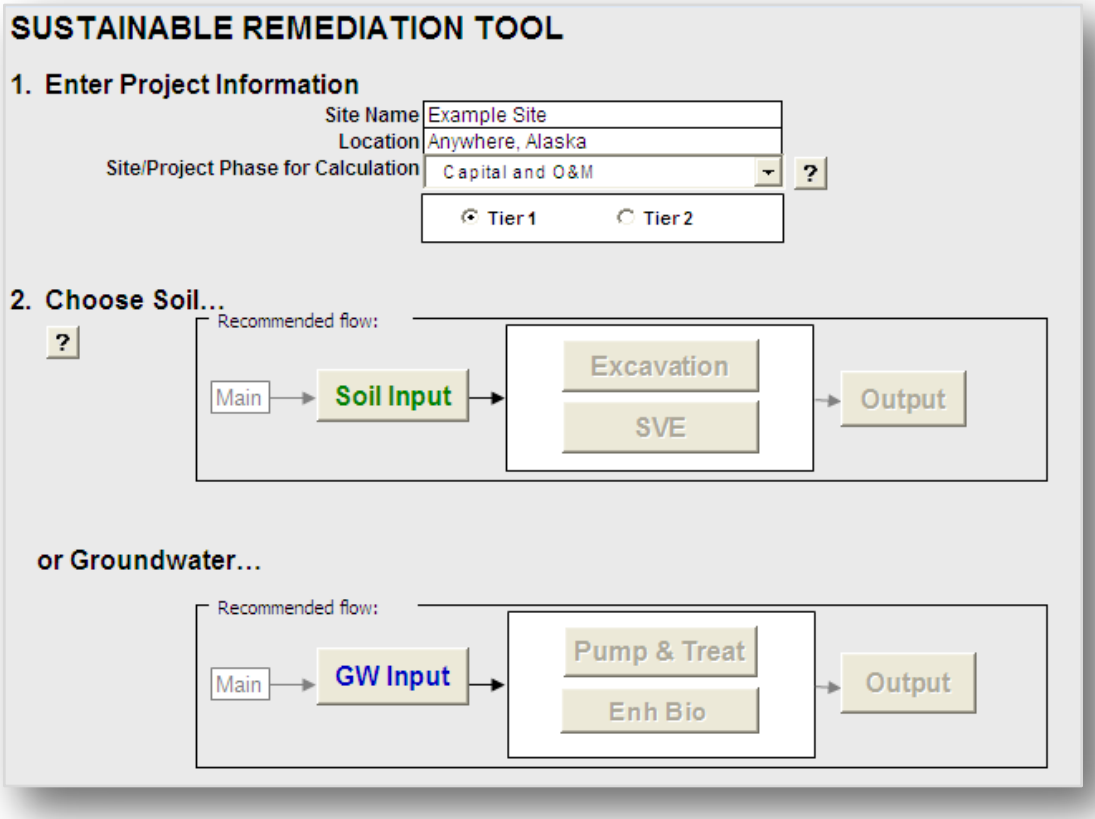




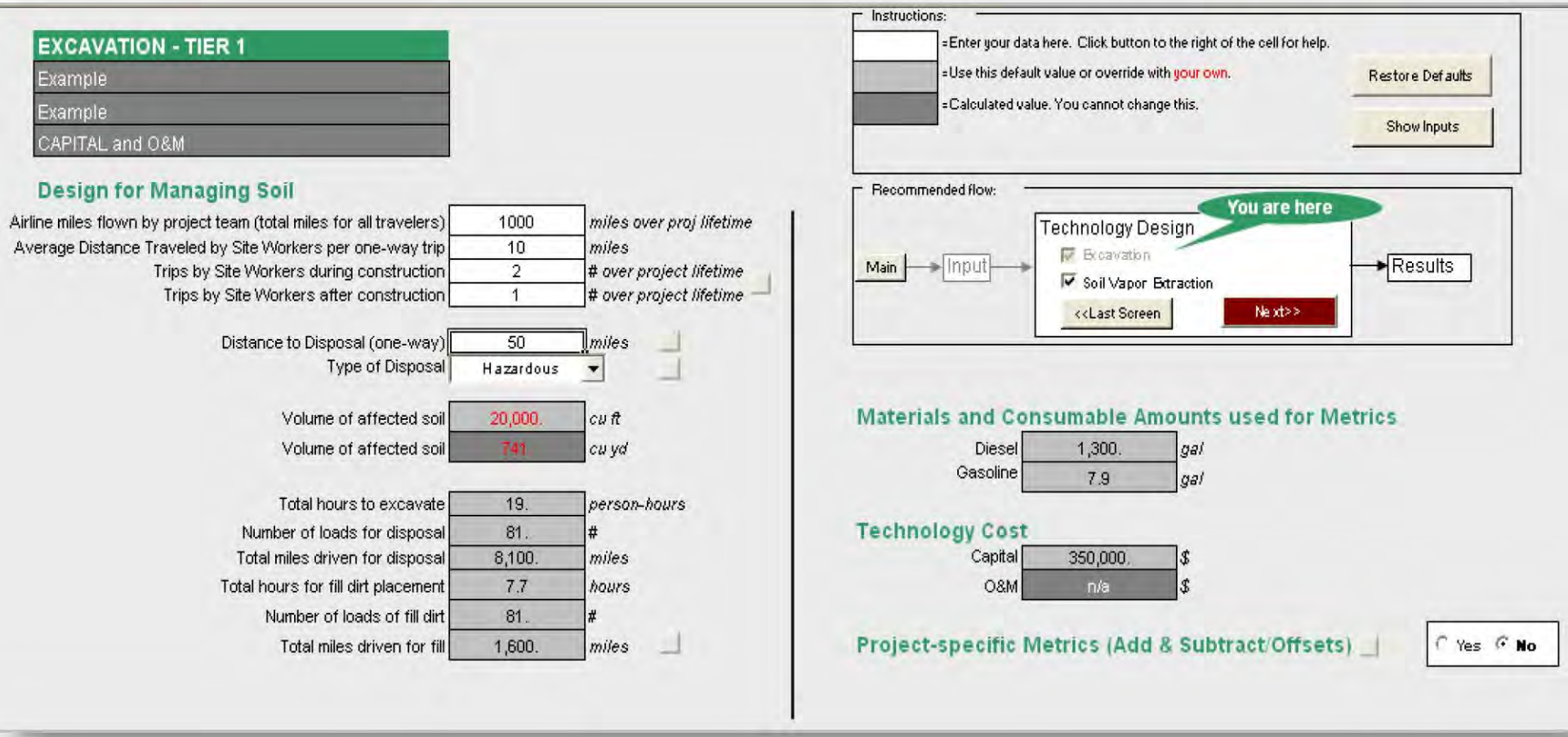
SRT – How Does it Work?

Basic Input Screen

- Once opened and saved, user taken to **Main Screen**.
  - **Site Name** and **Location**
  - **Site/Project Phase**
  - For **existing system,** choose "**O&M only**."
  - **Tier 1** or T**ier 2**
  - **Soil or groundwater**
  - **Help icons throughout**



SRT – How Does it Work?



EXCAVATION - TIER 1
Example
Example
CAPITAL and O&M

Design for Managing Soil

Airline miles flown by project team (total miles for all travelers)	1000	miles over proj lifetime
Average Distance Traveled by Site Workers per one-way trip	10	miles
Trips by Site Workers during construction	2	# over project lifetime
Trips by Site Workers after construction	1	# over project lifetime
Distance to Disposal (one-way)	50	miles
Type of Disposal	Hazardous	
Volume of affected soil	20,000.	cu ft
Volume of affected soil	741	cu yd
Total hours to excavate	19.	person-hours
Number of loads for disposal	81.	#
Total miles driven for disposal	8,100.	miles
Total hours for fill dirt placement	7.7	hours
Number of loads of fill dirt	81.	#
Total miles driven for fill	1,600.	miles

Instructions:
=Enter your data here. Click button to the right of the cell for help.
=Use this default value or override with your own.
=Calculated value. You cannot change this.
Restore Defaults
Show Inputs

Recommended flow:
Main → Input → Technology Design (You are here) → Results
Excavation
Soil Vapor Extraction
<<Last Screen
Next>>

Materials and Consumable Amounts used for Metrics

Diesel	1,300.	gal
Gasoline	7.9	gal

Technology Cost

Capital	350,000.	$
O&M	n/a	$

Project-specific Metrics (Add & Subtract/Offsets) — Yes / No

SRT – How Does it Work?

Example Carbon Emission Calculation

$$2{,}500\ \text{lb PVC} \times \frac{2\ \text{lb } CO_2}{1\ \text{lb PVC}} \times \frac{0.453\ \text{kg}}{1\ \text{lb}} \times \frac{0.001\ \text{metric ton}}{1\ \text{kg}} = 2\ \text{metric tons } CO_2 \text{ emitted}$$

"Non-normalized" natural units

$$\times \frac{\$5}{1\ \text{ton } CO_2} = \$10\ CO_2 \text{ offset}$$

"Normalized" $ units

Example Energy Consumed Metric

$$32\ \text{gal gas} \times \frac{150\ \text{MJ}}{1\ \text{gal gas}} = 4{,}800\ \text{MJ energy}$$

"Non-normalized" natural units

$$32\ \text{gal gas} \times \frac{\$42.00}{1\ \text{gal gas}} = \$64$$

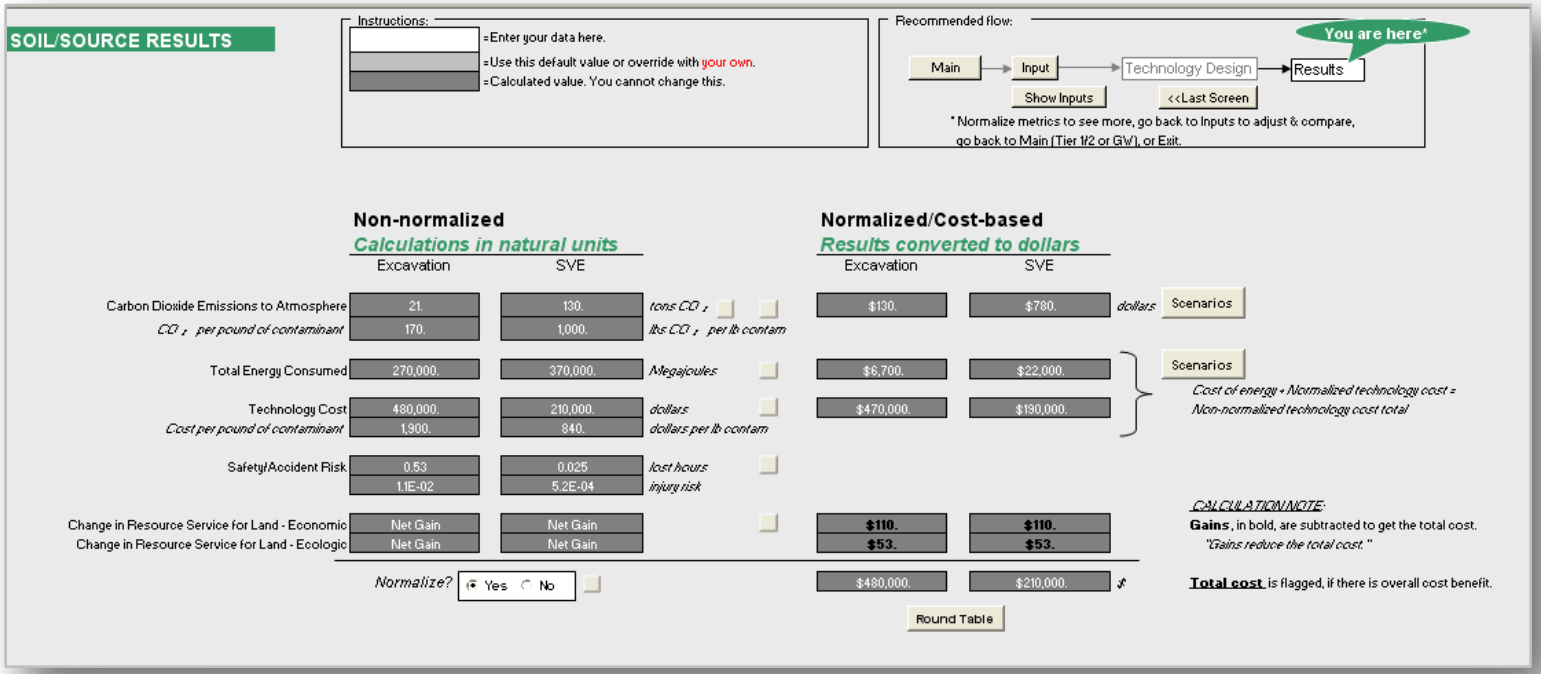
"Normalized" $ units

SRT – How Does it Work?

Output Screen

- **Normalized** or **non-normalized** results
- **NPV of technology cost** available
- **Gains subtracted** from normalized costs

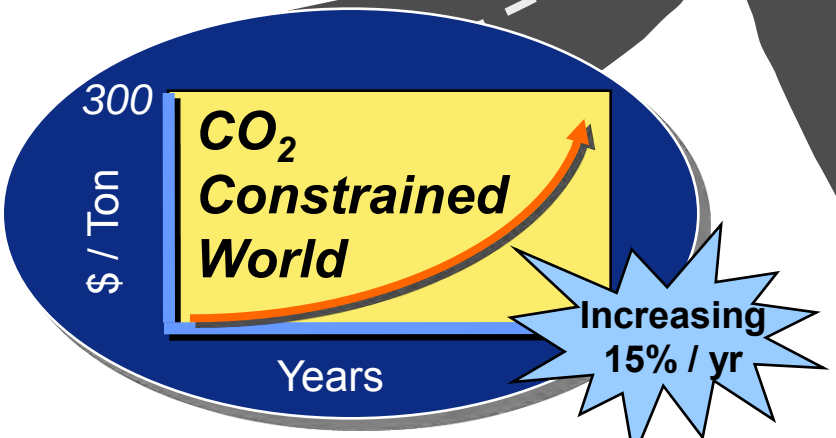
- Springboard for features:
  - **CO_2 Scenarios**
  - **Energy Scenarios**
  - **Stakeholder Roundtable**

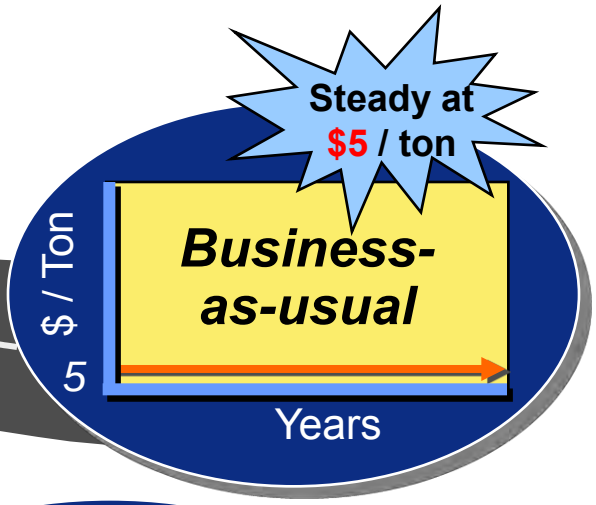


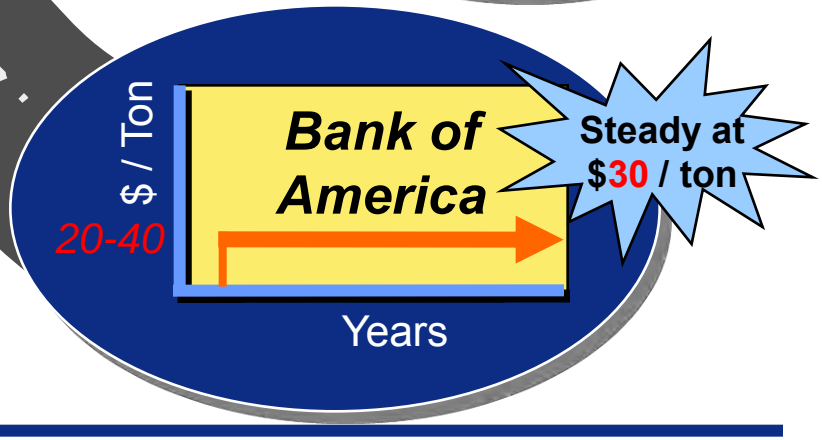
SRT – Feature

CO_2 Scenarios

Consider long-term costs of projects given various CO_2 scenarios







SRT – Feature

Stakeholder Roundtable - Reaching a Consensus

GROUNDWATER ROUND TABLE - WEIGH THE RESULTS

	Person 1	Person 2	Person 3	Person 4	Person 5
Carbon Dioxide Emissions to Atmosphere	High	Medium	Low	Don't Use	Medium
Total Energy Consumed	Medium	Low	Don't Use	High	Medium
Technology Cost	Low	Don't Use	High	Medium	Low
Change in Resource Service for Land	High	Medium	Low	Don't Use	High

Stakeholder Roundtable - Reaching a Consensus

Pump and Treat

Normalized/Cost-based Starting Point

Carbon Dioxide Emissions to Atmosphere	$340,000.	*dollars*
Total Energy Consumed	$8,700,000.	
Technology Cost	$58,000,000.	
Change in Resource Service	**$550,000.**	
	$57,000,000.	

Consensus (Average) Results

$310,000.	*dollars*
$7,800,000.	
$46,000,000.	
$610,000.	
$54,000,000.	

KEY POINT:

Starting cost is different than consensus cost

SRT – Status

Where We Are

- Beta testing
  - Completed February 2009
- Release of SRT
  - www.afcee.af.mil/resources/technologytransfer/programsandinitiatives/sustainableremeditation
  - email erica.becvar@brooks.af.mil

Where We Are Going

- Implementing through RPO
- Couple with use of PTT
- Additional technology modules and metrics
- Continuing to partner with regulators, industry, Services, etc.
- Potential integration with RACER™ costing tool

For Further Information

AFCEE ERP-O Website
www.afcee.af.mil/resources/restoration/rpo/index.asp

AFCEE Sustainable Remediation Web Site
www.afcee.af.mil/resources/technologytransfer/programsandinitiatives/sustainableremeditation/index.asp

EPA on Green Remediation
www.clu-in.org/greenremediation/

ITRC on Green Sustainable Remediation
www.itrcweb.org/teampublic_GSR.asp

2010 AFCEE Technology Transfer Workshop
www.afcee.af.mil/resources/technologytransfer/technologytransferworkshop/index.asp

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Questions / Discussion

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